

Accuracy of Clinical and Ultrasonographic Assessment of Fetal Weight in Obese Pregnant Women

Original
Article

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ABSTRACT

Objective: To assess the accuracy of clinical and ultrasonographic estimated fetal weight (EFW) at term pregnancy in predicting the actual birth weight (ABW) in different classes of obesity.

Patients and Methods: The study was conducted on 170 obese pregnant women who were divided into three groups according to body mass index (BMI) categories: Obesity class I ($n=102$), Obesity class II ($n=38$), and Obesity class III ($n=30$). All cases underwent predelivery ultrasonographic fetal biometry to get the EFW. Clinical assessment of the abdominal girth and symphysis-fundal height was also done, and then the EFW was calculated using Dare's and Johnson's formulas. After delivery, the ABW was compared with EFW, which was obtained by ultrasound and clinical assessment using Dare's and Johnson's formulas.

Results: We found the mean differences of EFW by ultrasound and ABW were 19.87, -86.05, and -176.80gm (in obesity class I, II, and III, respectively). While with clinical assessment, the mean differences of EFW and ABW were -15.98, -50.34, and -93.57gm when using Dare's formula, and 340.26, 438.03, and 297.67gm when using Johnson's formula (in obesity class I, II, and III, respectively).

Conclusion: Ultrasonographic assessment and Dare's formulas are more accurate than Johnson's formula in assessing fetal weight among all women with different obesity classes.

Key Words: BMI, birth weight, estimated fetal weight, obesity.

Received: 27 September 2025, **Accepted:** 01 October 2025.

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ISSN: 2090-7265, Vol. 15, 2025.

INTRODUCTION

The anticipation of estimated fetal weight (EFW) before childbirth in the third trimester is crucial, especially in obese women, as it significantly influences prenatal care decisions^[1]. Maternal obesity not only leads to obstetric difficulties but also hampers the ability to see the fetal anatomy clearly and reduces the quality of the images, making it challenging or even impossible to get suitable images for clinical analysis^[2]. Precise determination of fetal weight, gestational age, and mother's pelvic sufficiency are crucial data for the management of labor and delivery^[3].

Fetal Weight estimation by clinical assessment is a straightforward, convenient, and cost-effective method. However, it does not accurately measure the fetal size or weight; it just indicates that it may be too large to pass through the mother's birth canal^[4]. Numerous formulas and equations have been devised to estimate the weight of the fetus^[5]. Most of these methods combine measuring symphysis-fundal height (SFH) with additional factors. Some examples of these include the formulas known as Dare's formula and Johnson's formula^[6].

The Dare's Formula method involves measuring the circumference of the mother's abdomen, also known as abdominal girth, using a centimeter tape. The measurement findings are multiplied by the Uterine Fundus Height expressed in millimeters^[7].

The application of Johnson's method for estimating fetal weight and predicting the manner of birth based on the EFW will be pertinent to the primary care obstetric caregiver and other peripheral centers. It will assist them in making a more formal and objective assessment of fetal weight, enabling them to forecast the most probable delivery method. A quick referral can be made, particularly if the healthcare facility lacks the necessary cesarean delivery resources^[8].

Ultrasound is commonly employed in clinical practice to estimate the weight of the fetus. Clinicians find the parameters used to determine birth weight appealing because they are significant variables that impact perinatal mortality. Research has demonstrated that estimation using

many parameters can yield greater accuracy compared to estimation using a single parameter^[9].

This study aims to assess the accuracy of clinical and ultrasonographic EFW in term pregnancies in predicting the actual birth weight (ABW) in obese women of different body mass index (BMI) classes.

PATIENTS AND METHODS

This cross-sectional study was carried out at the labor ward of the Obstetrics and Gynecology Department, Faculty of Medicine, Cairo University Hospitals, between April 2023 and June 2024. The Research Ethics Committee of the Faculty of Medicine approved the study with registration number MS-522-2023. All procedures were carried out following applicable rules and legislation. All participants agreed after being told about the study's purpose and design and were given the option to leave at any time.

The study included pregnant women who met the following criteria: age of 20-35 years, BMI $\geq 30\text{kg/m}^2$, singleton pregnancy between 37-42 weeks, cephalic presentation, and those who were scheduled for labor induction with reactive CTG and elective cesarean section (CS). Women were excluded from this study in cases of multifetal pregnancy, placental abnormalities (i.e., placenta previa, placental abruption, and morbidly adherent placenta), structural or chromosomal fetal anomalies, intrauterine fetal death, obstetric emergencies (such as eclampsia or acute fetal distress), cases presented in the second stage of labor, cases who do not deliver within 48 hours of sonographic EFW assessment, cases with abnormal increased abdominal girth (such as fibroid uterus, ovarian masses, ascites) or cases with marked abdominal wall edema (such as hypoalbuminemia, renal impairment, and severe preeclampsia).

All participants were distributed based on their admission BMI, according to the WHO classification of obesity, into three groups: Group 1 of women with class I obesity ($30\text{-}34.9\text{kg/m}^2$), group 2 of women with class II obesity ($35\text{-}39.9\text{kg/m}^2$), and group 3 of women with class III obesity ($\geq 40\text{kg/m}^2$). They underwent complete history taking and clinical examination, including measuring abdominal girth [AG] (midway between the symphysis pubis and xiphi-sternal junction) and symphysis-fundal height [SFH].

To calculate the EFW, we used Dare's formula where EFW in gm = SFH in cm $\times$ AG in cm. We also used Johnson's formula, where the fetal weight in gm = (SFH in cm - n) $\times$ 155, where (n) is a station-specific constant. $n = 13$ when the vertex is above the ischial spine (the presenting portion is not engaged), $n = 12$ when the vertex is at the ischial spine level (the presenting portion is at station 0),

and $n = 11$ when the vertex is below the ischial spine (the presenting portion is engaged).

Antenatal ultrasound measurements of the fetal biometric parameters were done using Mindray DP-15 Digital Ultrasonic Diagnostic Imaging System ultrasound machine, 2–5MHz wide band convex curved array transducer, for confirmation of gestational age, fetal number, presentation, position, and placental location. The biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), and EFW were also obtained at each ultrasound examination. In all cases, an expert skilled medical sonographer did the fetal biometric measures within 48 hours before delivery.

Management of labor was done according to standard obstetric protocols, and the mode of delivery was determined according to obstetric indications. Our primary outcome was comparing the accuracy of ultrasound EFW with the accuracy of the clinical estimation of fetal weight using Johnson's formula and Dare's formula in different classes of obese pregnant women.

The sample size was estimated based on the accuracy of the third-trimester ultrasonographic assessment in predicting fetal birth weight in obese women. Ashrafganjooei *et al.*, (2010) indicated that the accuracy of ultrasonographic assessment in similar situations ranged from 72.2% to 93.5% with an average of $83\% \pm 10\%$ ^[10]. If we assumed that this was the true accuracy and variation, 170 pregnant mothers would be able to reject the null hypothesis with 80% power setting type I error probability to 0.05.

Statistical analysis:

Was done using the "Statistical Package for Social Sciences" v23 (SPSS Inc., Chicago, Illinois, USA). The quantitative variables were presented as mean $\pm$ standard deviation and ranges if normally distributed, while non-normally distributed variables were presented as median and inter-quartile range. On the other hand, qualitative variables were presented as numbers and percentages. To compare normally distributed variables, we used a one-way analysis of variance (ANOVA) test, while to compare non-normally distributed variables, we used the Kruskal-Wallis test. Comparing between groups regarding qualitative data was done by using the Chi-square test or Fisher's exact test. P -values ≤ 0.05 were considered significant.

RESULTS

Our study included 170 obese pregnant women who fulfilled the inclusion criteria. Table (1) demonstrates a comparison between the three groups regarding their baseline characteristics and the mode of delivery. There was no significant difference between the three groups concerning age and gestational age (p -value 0.062

and 0.208, respectively). Since the distribution of the participants in the study groups was based on obesity classification, there was a highly significant difference between the three groups regarding BMI (p -value<0.001). Vaginal delivery rates were significantly higher than CS rates in lower BMIs, while the opposite is observed in higher obesity classes where CS was more prevalent (p -value<0.001).

Table (2) compares the obesity classes regarding the ABW and the EFW by clinical and ultrasound assessment. There was a highly significant difference between the three

groups regarding the symphysis-fundal height and the abdominal girth (p -value<0.001). There was a higher EFW by Johnson's formula, Dare's formula, and ultrasound assessment and a higher ABW in obese class III, followed by obese class II, then obese class I.

Table (3) compares the EFW and the ABW in each obesity class. The EFW by Dare's formula and EFW by ultrasound results are close to the actual weight values, and there were no significant differences, with p -value (p >0.05); while the EFW by Johnson's formula results are significantly higher than actual weight values.

Table 1: Comparison between groups regarding baseline characteristics and the mode of delivery:

	Obesity class I (n= 102)	Obesity class II (n= 38)	Obesity class III (n= 30)	P-value
Age (years)	27.32±4.94 27(23-30)	29.58±5.79 30(25-34.75)	29.03 ± 5.32 29.5 (25.25 - 34.25)	0.062
BMI (kg/m ²)	32.48±1.42 32.4(31.23-33.30)	37.67±1.47 37.62(36.75-8.95)	43.68 ± 4.25 42.37 (40.54 -5.29)	<0.001*
Gravidity	2.36±1.69 2(1-3)	3.24±1.70 3.5(2-5)	4.53 ± 1.87 4 (3.25 - 6)	<0.001*
Parity	1.04±1.26 1(0-2)	1.79±1.45 1(1-3)	2.40 ± 1.35 2 (1.25 - 3)	<0.001*
Gestational age (weeks)	38.04±1.15 38(37-38)	38.18±1.06 38(37-39)	37.70 ± 0.47 38 (37 - 38)	0.208
Mode of delivery				
- VD	75(73.53%)	13(34.21%)	7(23.33%)	<0.001#
- CS	27(26.47%)	25(65.79%)	23(76.67%)	

Table 2: Comparison between groups regarding the actual birth weight (ABW) and the estimated fetal weight (EFW) by clinical and US assessment:

	Obesity class I (n= 102)	Obesity class II (n= 38)	Obesity class III (n=30)	P-value
Symphysis-fundal height (cm)	35.14±1.17 35(34.12-35.97)	36.49±1.16 36.45(35.9-37.37)	36.98±0.70 37(37-37.25)	< 0.001*
Abdominal girth (cm)	108.11±7.54 108(102-113)	115.13±9.77 116.5(107.5-121.5)	122.90±9.46 122(120-125.75)	< 0.001*
EFW by Johnson's formula (gm)	3432.34±180.77 3410(3274.75-3561.25)	3641.84±179.85 3635 (3550-3778.25)	3716.50±108.62 3720(3720-3759.25)	< 0.001*
EFW by Dare's formula (gm)	3076.10±184.22 3080.5(2934.25-3200)	3153.47±232.00 3146 (2978.25-3338.25)	3325.27±270.05 3310.5(3237-3426.75)	< 0.001*
EFW by US (gm)	3111.95±292.31 3100(2900-3253.75)	3117.76±345.69 3050(2862.5-3337.5)	3242.03±416.41 3104(2951.25-3503.75)	0.155
ABW (gm)	3092.08±218.82 3005(3000-3200)	3203.82±436.52 3152.5(3001.25-3403.75)	3418.83±319.22 3405(3166.25-3651.25)	< 0.001*

Table 3: Comparison between the estimated fetal weight (EFW) and the actual birth weight (ABW) in each group:

		Obesity class I (n= 102)	Obesity class II (n= 38)	Obesity class III (n= 30)
EFW by Johnson's formula (gm)–ABW(gm)	Mean diff±SE P-value	340.26 ±16.73 P<0.001*	438.03 ±63.89 P<0.001*	297.67 ±49.48 P<0.001*
EFW by Dare's formula (gm)–ABW(gm)	Mean diff±SE P-value	-15.98±23.76 P= 0.503	-50.34 ±71.05 P= 0.483	-93.57 ±87.22 P= 0.292
EFW by ultrasound (gm)–ABW(gm)	Mean diff±SE P-value	19.87 ±16.72 P= 0.238	-86.05 ±57.47 P= 0.143	-176.80 ±86.82 P= 0.051

DISCUSSION

Fetal weight estimation is of key importance in the decision-making process for obstetric planning and management^[11]. The research is mixed about the accuracy of measures using either ultrasonography or clinical examination^[12]. Maternal BMI could be a confounding factor as maternal obesity can influence the accuracy of EFW obtained by ultrasound^[13,14]. Consequently, this study was conducted to estimate the effect of maternal BMI on clinical and ultrasonographic EFW in term pregnancies and their correlation with the ABW.

Our study revealed that ultrasound and Dare's formulas were more accurate than Johnson's formula in assessing fetal weight among all study groups with different body mass indices. Out of the study scope, we observed that the CS rate was directly related to the increase in obesity class. This could be attributed to the fact that obese women might be less likely to deliver vaginally due to lower physical activity rates, higher incidence of gestational diabetes, and higher incidence of fetal macrosomia. We also observed that increased gravidity and parity were associated with increased obesity class. This might be multifactorial as multigravidas may have higher mean age and higher incidence of comorbidities and can be attributed to a different nutritional attitude in larger family contexts, especially if low income reflected in quality of nutrition and leads to a shift towards low protein and higher carbohydrate diet leading to obesity.

De Oliveira *et al.*, (2019) reported that the accuracy of ultrasound and Dare's and Johnson's formula in estimating fetal weight in obese women varies depending on factors such as maternal obesity, fetal position, and maternal weight estimation. Although predelivery ultrasound is generally considered more accurate, the thickness of the abdominal wall in obese women can make it more difficult to obtain accurate ultrasound measurements. In addition, Dare's and Johnson's formula may be useful in settings where ultrasound is unavailable^[15].

El-Sayed *et al.*, (2020) reported that predelivery ultrasound is generally preferred over Johnson's formula for estimating fetal weight due to its superior accuracy. In addition, these formulas may be less reliable in obese women due to variations in maternal body composition. However, these formulas can still be useful screening tools, are considered more suitable in primary care settings, and are less expensive than ultrasound^[16]. Anitha and Kanagal (2021) also investigated the accuracy of clinical and sonographic fetal weight assessment at term-pregnant patients before delivery to predict birth weight. They indicated that clinical approaches with Dare's formula might be a potentially encouraged choice for determining fetal weight without ultrasonography^[17].

Ricchi *et al.*, (2021) assessed the reliability of the symphysis-fundus technique by Johnson's formula in estimating fetal weight in lower-risk pregnancy cases using the following classification: small, adequate, or large for gestational age. Across the whole group, fetal weight was approximated equally using the clinical approach and ultrasonography (79.5 vs. 85%). However, in overweight women, ultrasound better estimates fetal weight than the clinical approach (94.4 vs. 80.3%), and similarly, in obese women, ultrasound performed better than the clinical method (91.8 vs. 71.4%). They reported that clinical assessment might be deemed a viable way to measure fetal weight for treating lower-risk pregnancy cases, allowing resources to be optimized while also providing a safe, nonmedical approach^[18].

Zhang *et al.*, (2022) conducted a study of 2,517 pregnant women. The overall CS rate was 25.8%. The CS rate was highest in the obese group (35.7%), followed by the overweight group (28.9%), the normal weight group (22.5%), and the underweight group (18.3%). After adjusting for confounders, obesity was significantly associated with an increased risk of CS (aOR: 1.69, 95% CI: 1.26-2.28). The risk of CS was increased in class I (30-34.9kg/m²) and class II (35-39.9kg/m²) obesity. They concluded that there is a strong association between obesity and increased risk of CS. Women with obesity had a significantly higher risk of undergoing a CS compared to women with a normal BMI. These findings highlight the importance of addressing obesity during pregnancy and the need for tailored prenatal care for obese women to reduce the risk of cesarean delivery^[19].

The strengths of this study include comparing the accuracy of clinical and sonographic estimation of fetal weight at term pregnancy in predicting the actual birth weight (ABW) in different classes of obesity. Furthermore, possible confounders such as multifetal pregnancy were excluded, all sonographic data were obtained using the same machines and settings, and the same team completed all clinical assessments and evaluations of study outcomes. The points of weakness include that the study was hospital-based, had a small sample size relative to study outcomes, and was not multicentric; hence, it represented a single community.

DECLARATIONS

Ethical approval:

The Research Ethics Committee of the Faculty of Medicine approved the study with registration number MS-522-2023. All methods were carried out per relevant guidelines and regulations.

Informed consent:

All participants gave their consent after being informed of the study's objective and design, and they were given the option to leave the study at any time.

Consent for publication: Not Applicable.

Availability of data and materials:

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

CONCLUSION

Better accuracy of EFW could be achieved in obese pregnant women via ultrasound assessment and clinical assessment with Dare's formulas compared to clinical assessment with Johnson's formulas. Thus, Dare's formula may be recommended as a substitute for ultrasound equipment for estimating fetal weight in primary healthcare settings.

Further research is needed to evaluate the accuracy of EFW in normal-weight women. Training in clinical assessment with Dare's formulas is crucial and can be integral to antenatal care in primary healthcare settings.

FUNDING

There is no specific grant from any funding agency.

CONFLICT OF INTERESTS

There is no conflict of interests.

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